EXHIBIT A

AMERICAN RAILWAY ENGINEERING ASSOCIATION

[1]Part 2

Specifications

[1]SPECIFICATIONS FOR STEEL RAILS

(Reapproved with revisions 1994)

1. Scope

1.1 These specifications cover steel tee rails weighing 115 lb./yd. and over for use in railway track.

1.2 Drawings of recommended rail sections are shown on pages 4-1-3 through 4-1-7 of this manual.

1.3 ASTM Specifications A 1, A 2, and A 759 are referenced for tee rails weighing 60 lb./yd. and over, girder rails, and crane rails, respectively.

1.4 Supplementary requirements S1 and S2 shall apply only when specified by the purchaser.

2. Manufacture

2.1 The steel shall be made by any of the following processes: open hearth, basic oxygen, or electric furnace.

2.2 The steel shall be cast by a continuous process, in hot topped ingots, or by other methods agreed by purchaser and manufacturer.

2.3 Sufficient discard shall be taken from ingots and blooms rolled from ingots to insure freedom from injurious segregation and pipe.

2.4 Rails shall be furnished in the as-rolled (standard and alloy), head-hardened, fully-heat-treated, or on-line-hardened conditions as agreed by purchaser and manufacturer.

[1]References, Vol. 3, 1902, pp. 204, 208; Vol. 5, 1904, pp. 455, 469; Vol. 6, 1905, pp. 183; Vol. 7, 1906, pp. 549, 573, Vol. 10, 1909, part 1, pp. 374, 393; Vol. 11, 1910, part 1, pp. 237, 255; Vol. 12, 1911, part 1, p. 467, Vol. 12, 1911, part 2, p. 12; Vol. 13, 1912, pp. 853, 1017; Vol. 14, 1913, pp. 181, 1103; Vol. 15, 1914, pp. 158, 375; Vol. 16, 1915, pp. 1117; Vol. 21, 1920, pp. 1070, 1447; Vol. 26, 1930, pp. 619, 1413; Vol. 31, 1930, pp. 1455, 1770; Vol. 32, 1931, pp. 347, 816; Vol. 36, 1935, pp. 606, 821; Vol. 37, 1936, pp. 426, 991; Vol. 38, 1937, pp. 216, 635; Vol. 40, 1939, pp. 596, 738; Vol. 43, 1942, pp. 575, 704; Vol. 47, 1946, pp. 373, 625; Vol. 52, 1951, pp. 596, 824; Vol. 54, 1953, pp. 1177, 1413; Vol. 55, 1954, pp. 775, 1098; Vol. 57, 1956, pp. 786, 1088; Vol. 58, 1957, pp. 962, 1248; Vol. 63, 1962, pp. 501, 768; Vol. 64, 1963, pp. 498, 690; Vol. 65, 1964, pp. 521, 851; Vol. 68, 1967, p. 408; Vol. 69, 1968, p. 336; Vol. 71, 1970, p. 223; Vol. 75, 1974, p. 479; Vol. 80, 1979, p. 82; Vol. 85, 1984, p. 13; Vol. 87, 1986, p. 69; Vol. 89, 1988, p. 71; Vol. 92, 1991, p. 58; Vol. 93, 1992, p. 57; Vol. 94, p. 67; Vol. 94, 1994, p. 54.

3. Chemical Composition

3.1 The chemical composition of the standard rail steel determined as prescribed in 3.3 shall be within the following limits:

	Chemical Analysis, Weight Percent		Product Analysis, Weight Percent Allowance Beyond Limits of Specified Chemical Analysis	
Element	Min.	Max.	Under Min.	Over Max.
Carbon	0.72	0.82	0.04	0.04
Manganese	0.80*	1.10*	0.06	0.06
Phosphorus	—	0.035	—	0.008
Sulfur	—	0.037	—	0.008
Silicon	0.10	0.60	0.02	0.05
Nickel		*		
Chromium		*		
Molybdenum		*		
Vanadium		*		

*The manganese and residual element limits may be varied by the manufacturer to meet the mechanical property requirements as follows:

Manganese		Nickel	Chromium	Molybdenum	Vanadium
Min.	Max.	Max.	Max.	Max.	Max.
0.60	0.79	0.25	0.50	0.10	0.03
1.11	1.25	0.25	0.25	0.10	0.05

3.1.1 Finished material representing the heat may be product tested. The product analysis shall be within the limits for product analyses specified in 3.1.

3.2 The chemical composition limits of alloy high-strength rail is subject to agreement of the purchaser and manufacturer.

3.3 Separate analysis shall be made from test samples representing one of the first three and one of the last three ingots or continuously cast blooms preferably taken during pouring of the heat. Determination may be made chemically or spectrographically. Any portion of the heat meeting the chemical analysis requirements of 3.1 may be applied. Additionally, any material meeting the product analysis limits shown in 3.1 may be applied after testing such material.

3.4 Upon request by the purchaser, samples shall be furnished to verify the analysis as determined in 3.3

3.5 The first analysis shall be recorded as the official heat analysis, but the purchaser shall have access to all chemical analysis determinations.

3.6 Rail heats shall be tested for hydrogen content using either a sampling/analytical method or a direct measurement method. The testing shall be performed either during the continuous casting process or during ingot teeming. Hydrogen content (*) shall be recorded and available for review or reporting at the request of the purchaser. The producer shall define the method used to determine

hydrogen content, which of the following methods are used for hydrogen removal, and present evidence of applicable procedures used to control the final rail hydrogen.

- Vacuum Degassing
- Bloom Control Cooling
- Rail Control Cooling

*(Note: As a result of the use of different methods and reporting procedures, the comparison of hydrogen levels between various rail producers may not be appropriate.)

4. Mechanical Properties

4.1 Surface Hardness

4.1.1 Rails shall be produced as specified by the purchaser within the following limits:

	Brinell Hardness, HB	
	Minimum	Maximum
Standard Rail	300	—
High-Strength Rail (alloy and heat treated)	341	388*

*May be exceeded provided a fully pearlitic microstructure is maintained.

4.1.2 The Brinell hardness test shall be performed on a rail or a piece of rail at least 6 inches long cut from a rail of each heat of steel or heat-treatment lot. A test report shall be furnished to the purchaser.

4.1.2.1 The test shall be made on the side or top of the rail head after decarburized material has been removed to permit an accurate determination of hardness.

4.1.2.2 The test shall otherwise be conducted in accordance with ASTM E 10, "Standard Test Method for Brinell Hardness of Metallic Materials," latest version.

4.1.3 If any hardness test result fails to meet the specifications, two additional checks shall be made on the same piece. If both checks meet the specified hardness, the heat or heat treatment lot meets the hardness requirement. If either of the additional checks fails, two further rails in the heat or lot shall be checked. Both of these checks must be satisfactory for the heat or lot to be accepted. If any one of these two checks fails, individual rails may be tested for acceptance.

4.1.4 If the results for heat-treated rails fails to meet the requirements of 4.1.1, the rails may be retreated at the option of the manufacturer, an such rails shall be retested in accordance with 4.1.2 and 4.1.3.

4.2 Internal Hardness of High Strength Rail

4.2.1 The internal hardness of high strength rail shall be determined on a transverse specimen cut from the head and at least six inches from the end of the rail. The specimen shall be ground so that the transverse surfaces are parallel.

4.2.2. The hardness shall be determined at intervals of not greater than 1/8 inch along traverses 1, 2, and 3 and at positions 4 and 5 as shown in Figure 4.1. Traverse 2 can extend into the web of the rail (X + 1.6") upon agreement between the purchaser and the manufacturer.

4.2.3 The hardness tests shall be conducted with either of the following methods: Brinell (ASTM E10*), Rockwell (ASTM E18**), or Vickers (ASTM E92***). The results shall be reported in the units of the method used. The results shall be reported in Brinell (using ASTM E140**** for conversion) when requested by the purchaser.

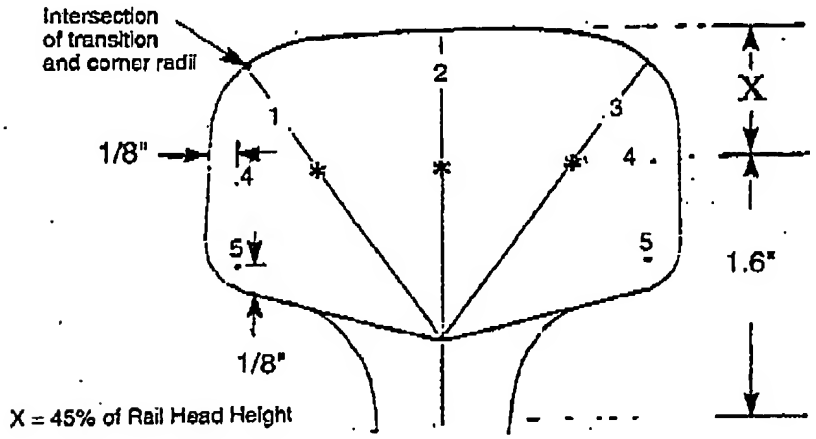
*ASTM E10 Standard Test Method for Brinell Hardness of Metallic Materials.
**ASTM E18 Standard Test Method for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
***ASTM E92 Standard Test Method for Vickers Hardness of Metallic Materials.
****ASTM E140 Standard Hardness Conversion Tables for Metals.

4.2.4 The hardness at a depth of 3/8 inch on lines 1, 2, and 3 and at points 4 and 5 of Figure 4.1, shall be 341HB or higher.

4.2.5 The testing frequency shall be one test per heat or 10,000 feet of rail, whichever is the smaller amount of rail.

4.2.6 If any test specimen fails to meet the required hardness, two additional test specimens shall be obtained from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the specimens fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of these tests must be satisfactory for the lot to be accepted. If on of the tests is unsatisfactory, individual rails may be sampled and tested for acceptance.

4.2.8 If the results for heat-treated rail fail to meet the requirements, the rails represented by the test may be reheat-treated and tested.



	115#	119#	132#	133#	136#	140#
X	3/4" 0.750"	27/32" 0.844"	25/32" 0.781"	7/8" 0.875"	7/8" 0.875"	15/16" 0.938"

Figure 4.1

4.3 Tensile Properties

4.3.1 Rails shall be produced as specified by the purchaser within the following limits.

	Standard	High-Strength
Yield Strength, ksi, minimum	70	110
Tensile Strength, ksi, minimum	140	170
Elongation in 2 inch, percent, minimum	9	10

4.3.2 One longitudinal tension test specimen shall be taken from the gauge corner of the rail head, centered 1/2 inch from the gauge side and 1/2 inch from the running surface.

4.3.3 The specimen shall be 0.5 inch diameter and shall be tested per ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

4.3.4 For standard rail, the test frequency shall be one test for each heat for the first one hundred heats, one test for every fifth heat for the second hundred heats and one test for every tenth heat thereafter for heats furnished to the same customer.

4.3.5 For high-strength rail, the testing frequency shall be one test per heat or 10,000 feet of rail, whichever is the smallest amount of rail.

4.3.6 If any test specimen fails because of a malfunction of the test equipment or a flaw in the specimen, it shall be discarded and another one taken.

4.3.7 If a test specimen fails to meet the required tensile properties, two additional test specimens shall be cut from rails from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the tests fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of the tests must be satisfactory for the lot to be accepted. If one of these tests is unsatisfactory, individual rails may be sampled and tested for acceptance.

4.3.8 If the results for heat-treated high-strength rail fail to meet the requirements, the rails represented by the test may be reheat-treated and retested.

5. Section

5.1 The section of the rails shall conform to the design specified by the purchaser subject to the following tolerances on dimensions.

	Inches (Thousandths) Plus	Minus
5.1.1 height of rail (measured within 1 ft. from end)	0.040	0.015
5.1.2 width of rail head (measured within 1 ft. from end)	0.030	0.030
5.1.3 thickness of web	0.040	0.020
5.1.4 width of either flange	0.040	0.040
5.1.5 width of base	0.050	0.050

5.1.6 Base concavity shall not exceed 0.010". Convexity is not permitted.

5.1.7 No variation will be allowed in dimensions affecting the fit of the joint bars, except that the fishing templet may stand out not to exceed 0.060" laterally.

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5.2 Verification of tolerances shall be made using appropriate gages, as agreed upon by purchaser and manufacturer.

6. Branding and Stamping

6.1 Branding shall be rolled in raised characters on the side of the web of each rail at a minimum of every 16 ft. in accordance with the following requirements:

6.1.1 The data and order of arrangement of the branding shall be as shown in the following typical brand, the design of letters and numerals to be optional with the manufacturer.

132 (Weight)	RE (Section)	CC (Method of Hydrogen Elimination if indicated in Brand)	Manufacturer (Mill Brand)	1982 (Year Rolled)	III (Month Rolled)

6.2 The web of each rail shall be hot stamped at a minimum of every 16 ft. on the side opposite the brand, and shall not occur within two feet of either end of rails of standard lengths, and in accordance with the following requirements:

6.2.1 The data shall be shown in the following typical stamping. The height of the letters and numerals shall be 5/8".

297165 (Heat Number)	ABCDEFGH (Rail Letter)	12 (Ingot Number) or (Strand & Bloom Number)	BC (Method of Hydrogen Elimination, if indicated in stamping)

6.2.2 The top rail from each ingot shall normally be hot stamped "A" and succeeding ones "B", "C", "D", "E", etc., consecutively.

6.2.2.1 The top rail from each hot topped ingot may be hot stamped "B" and succeeding ones "C", "D", "E", etc. consecutively, when agreed between purchaser and manufacturer.

6.2.3 Ingots shall be numbered in the order cast.

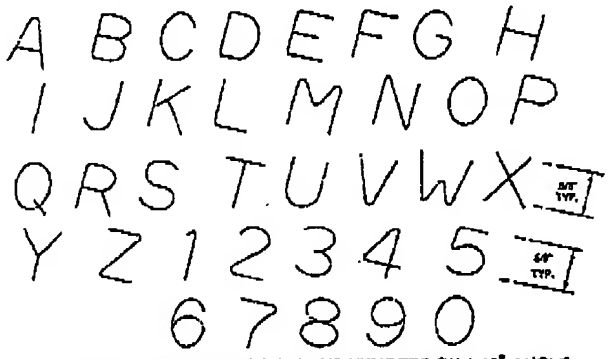
6.2.4 Rails from continuous cast blooms shall be identified by a designation for heat number, strand number, and bloom number.

(Note strand and bloom numbers may be joined or may be coded at the manufacturer's option).

The rail shall be identified by an alphabetical designation beginning with "P", and succeeding "R", "S", "T", etc., consecutively, or any other identification of the position of the rail within the cast, as agreed between the purchaser and manufacturer.

6.2.5. The 5/8" stamped characters shall have a flat or radius face (0.040" to 0.060" wide) with bevels on each side so as not to produce metallurgical stress risers. The letters and numbers shall be on a 10° angle

from vertical and shall have rounded corners. The stamping shall be 0.020" and 0.060" in depth along the center of the web. The design shall be as shown in Figure 6.1.



DESIGN OF SPECIAL LETTERS AND NUMBERS ON A 10° ANGLE FOR RAIL STAMPS, NO SHARP CORNERS

Figure 6.1

6.2.6 High strength rail shall be identified in accordance with Section 15.1.

7. Hydrogen Elimination

7.1 The rail shall be free from shatter cracks.

7.2 The above shall be accomplished by at least one of the following processes:

Control Cooling of Rails (CC) (See Appendix 1)
Control Cooling of Blooms (BC)
Vacuum Treated (VT)
Such other processes as will meet the conditions of 7.1 (OP)

7.3 The mill brand or stamp shall identify the process used by the initials in parentheses shown in Section 7.2.

8. Ultrasonic Testing

8.1 Rails shall be ultrasonically tested for internal imperfections subject to the provisions of 8.2 through 8.8.

8.2 Full length of the rail shall be tested using in line ultrasonic testing equipment provided by the manufacturer except, if agreed to between purchaser and manufacturer, rails may be tested in accordance with Supplementary requirement S2. The rail shall be free from rough surfaces, loose scale or foreign matter which would interfere with the ultrasonic detection of defects. Testing shall be done when the rail temperature is below 150°F.

8.3 The calibration test rail shall be a full section rail of the same section as that being tested. The test rail shall be long enough to allow calibration at the same rate of speed as the production rail.

8.4 The size, shape, location and orientation of calibration references to be placed in the test rail shall be agreed upon by the purchaser and manufacturer. At least one reference shall be put into the test rail to represent each search unit in the system.

8.4.1 The in-line testing system sensitivity level, using the calibration rail, shall be adjusted to detect a minimum 3/32 in. diameter defect anywhere in the sound path in the head, a minimum of 1/16 in. diameter in the web, and longitudinal imperfections exceeding 1/2 in. length and greater than 1/16 in. depth occuring in the base.

8.4.2 Any indication equal to or greater than the references specified in 8.4.1 when scanning the rail at the production speed shall be cause for initial rejection. A record shall be made of each suspect rail. This record shall be available to the purchaser's inspector.

8.5 The calibration rail shall be run through the ultrasonic testing equipment at the start of each shift or at least once each 8 hour operating turn and additionally at any section change or at any indication of equipment malfunction. A record shall be maintained by the manufacturer of each time the calibration test rail is run through the test system. This record shall be available to the purchaser's inspector.

8.6 In the event of a calibration failure, all rails processed since the last successful calibration shall be retested.

8.7 The suspect rail may be retested using manual non-destructive testing techniques before final rejection. The testing criteria of the manual non-destructive retesting shall be in accordance with Section 8.4. The method of inspection shall be agreed to between purchaser and manufacturer.

8.8 Rejected rails shall be cut back to sound metal as indicated by the ultrasonic testing subject to the length restrictions in Section 11. The cut shall be a minimum of 12 inches from any indication.

9. Interior Condition/Macroetch Standards

9.1 Sample Location and Frequency

9.1.1 Ingot Steel - A test piece representing the top end of the top rail from one of the first three, middle three, and last three ingots of each heat shall be macroetched.

9.1.2 Continuous Cast Steel - A test piece shall be macroetched representing a rail from each strand from the beginning of each sequence and whenever a new ladle is begun, which is the point representative of the lowest level in the tundish (i.e. the point of lowest ferrostatic pressure.) One additional sample from the end of each strand of the last heat in the sequence shall also be tested. A new tundish is considered to be the beginning of a new sequence.

9.1.3 Upon receipt the purchaser has the right to examine any rail from any part of a heat at his option, and if the purchaser determines that the rail sample selected is rejectionable, the entire heat shall be re-evaluated according to Section 9.4.

9.2 Sample Preparation

9.2.1 A full transverse section of the rail can be cut by abrasive or mechanical means as long as care is maintained in preventing metallurgical damage.

9.2.2 The face to be etched shall have at least a 125 microinch finish.

9.2.3 The sample shall be degreased and totally immersed in a hot (160° to 180°F) one to one mixture, by volume, of concentrated hydrochloric acid (38 volume percent) and water to sufficiently etch the specimen. Etching time shall be between ten and twenty minutes. The solution surface shall be at least one inch above the etched surface.

9.2.4 Upon removal from the bath, the sample shall be rinsed and brushed under hot water and dried. The sample shall not be blotted dry. A rust inhibitor may be applied to the etched face at the request of the purchaser.

9.3 Macroetch Evaluation

9.3.1 According to Figure 9.1., the areas of cross section shall be defined as head, web, and base. Schematic descriptions of some rejectionable conditions are depicted in Figures 9.2 through 9.10. Photographs of rejectionable conditions are presented in Appendix 2.